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Scientific Course SC4

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Abstract

Through the Doc-TIC PhD Programme a number of course modules in areas related to photonics (active and passive devices), quantum mechanics, solid-state physics and integrated photonics are given to the ESRs. This Scientific-based course (SC4) offered to each ESR is a hands on session on Photonic Design Automation for core and metro WDM systems, optical access networks, lasers as well as active devices and circuits.

Keywords: Photonic design automation, simulation, Physics, Solid-state physics, Training

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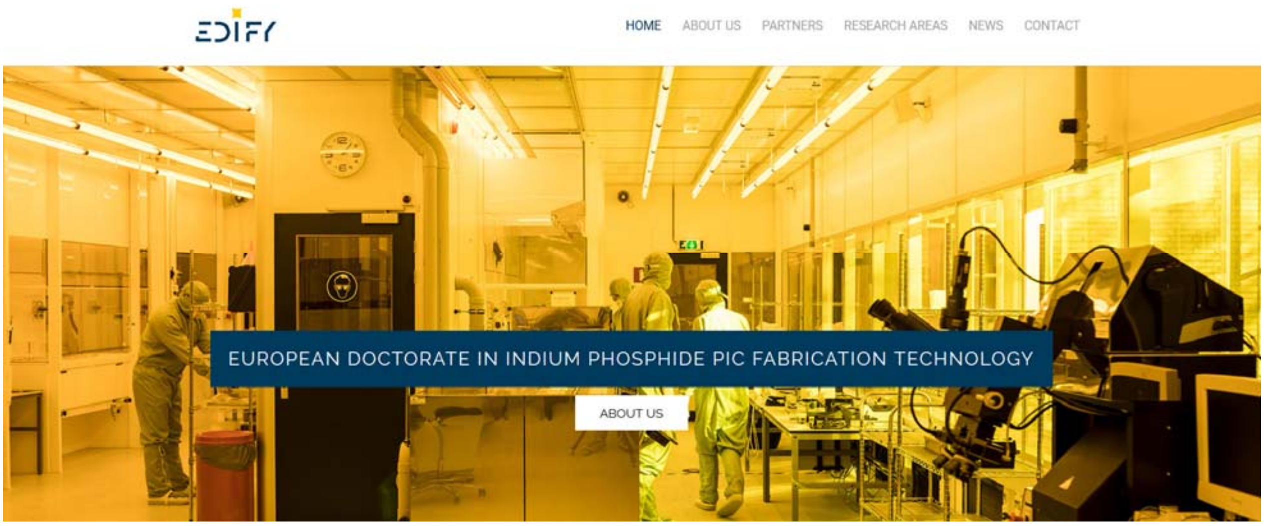
HOME
ABOUT US
PARTNERS
RESEARCH AREAS
NEWS
CONTACT
EUROPEAN DOCTORATE IN INDIUM PHOSPHIDE PIC FABRICATION TECHNOLOGY
ABOUT US


EDIFY

TABLE OF CONTENTS

1. INTRODUCTION

The aim of this report is to provide a brief overview of the first **Scientific Course 4** organized in the framework of the project EDIFY. As a general introduction, the challenge for the EDIFY Training Network is to develop new fundamental skills on simulation, design, measurement automation, fabrication and validation, and organization in an integrated photonics foundry. These are intended to develop a new generation of technology advances in material and semiconductor properties aimed for low loss waveguides to develop more efficient passive devices as well as aluminium containing quantum wells for active devices like semiconductor optical amplifiers, saturable absorbers modulators and lasers. To achieve this, the EDIFY training strategy aims to combine scientific advanced training (Scientific Courses 1-5), technical hands-on courses (TC1-3), Winter School and regular EID meetings and networking events. Furthermore, all ESRs will be equipped with a range of transferable skills, as defined in the proposal.

The following specific training objectives (TOs) are defined to fulfill these goals:

- TO1: To enhance the attractiveness of a career in the front-line area of research in integrated photonics InP design, fabrication, characterization and modelling. To provide the opportunity for the fellows to be involved in the creation of a new line of industrial automation and organization of tasks in the InP foundry.
- TO2: To provide academic and industrial sector employers with researchers skilled in a wide range of techniques and methods, and direct experience of interaction across disciplines and sectors.
- TO3: To produce researchers with excellent transferable skills and the ability to transform abstract and challenging ideas into influential and practical outcomes.
- TO4: To create an active, long-term network of young researchers whose personal contacts, support and expertise will help Europe shape the future of research in active/passive devices and enhance/optimize the process of automated integrated photonics fabrication to enable the future of photonics industry in Europe in the next years.
- TO5: To cascade expertise and spread good practice throughout Europe by personnel exchange, and delivering European researchers able to become leaders in the fields of integrated photonics design, fabrication and characterization and industrial organization and automation in photonics industry in the near and mid-term future.

The four ESRs **have been enrolled (07/10/2019) in the PhD program from the UVigo (Doc-TIC)**. Doc-TIC is the PhD Program promoted by the School of Telecommunications Engineering and atlanTTic. Its mission is to train the best professionals and researchers to generate quality research with international impact and to provide the industry with professionals with advanced knowledge to improve its competitiveness at global level. Doc-TIC involves the merging and expansion of the previous PhD Programmes in Signal Theory and Communications (TSC) and Telematics Engineering, both with Mention of Excellence awarded by the Spanish Ministry of Education. Each ESR will be required to accumulate at least 30 ECTS (European Credit Transfer and Accumulation System) credits, among the pool of scientific- and transferable skills-based courses at UVigo and TUe **to obtain their PhD title**.

Through the Doc-TIC PhD Programme the UVigo offers a number of **course modules in areas related to photonics (active and passive devices), quantum mechanics, solid-state physics**, all of which are given in English. Between them, this **Scientific-based course (SC4)** offered to each ESR is a **hands on session** on Photonic Design Automation for core and metro WDM systems, optical access networks, lasers as well as active devices and circuits. It will grant 5 ECTS to each ESR (20 lecturing hours and 40 hours of homework).

1.1 SCIENTIFIC COURSE 4

In the following Table we describe the fundamentals of this scientific-based training course and corresponding skills to be acquired by the ESRs.

Title	*Phoenix and Photon Design intensive training (SC4)*	Month: 9	Duration: 1 Week
Lead	UVigo		
Contents: Training seminars and hands on session on Photonic Design Automation for core and metro WDM systems, optical access networks, lasers as well as active devices and circuits. Experts in the field of photonic modelling lead guided tours, provide lectures on various application topics, and are available for questions and support during individual lab exercises. Design topics include: Graphical User Interface features; Overview of signal models and simulation techniques; Parameter sweeps and optimizations; Visualization and post-processing of simulation results; Scripted simulations and automated system design.			
Skills for ESRs: Active/Passive photonic integrated circuits; Semiconductor lasers and other active photonic devices; Integrated photonic waveguides; Doped-fiber lasers and amplifiers; Hybrid (EDF/Raman) amplification and Raman pump optimization; Co-simulation (integration of third-party code).			

1.2 SYLLABUS

The outline of the course is described below.

Optodesigner and Photon Design Intensive Training

1. PICWave: an advanced laser diode and SOA model, a powerful photonic integrated circuit (PIC) design and simulation tool, a flexible design flow environment.
    a. Introduction. How to design PICs using pre-defined design kits.
    b. The calculation engine of PICWave. A powerful and flexible time-domain travelling wave (TDTW) model, from which almost all other results are derived.
    c. PICWave devices. Any number of passive elements like waveguides, Y-junctions, directional couplers, mirrors, plus active components like an SOA or an electro-

absorption modulator. LRC electrical circuits can then be connected to drive the circuit.

2. FIMMWave: Waveguide Mode solvers. FIMMWAVE is a suite of robust and fully vectorial mode solvers for 2D+Z waveguide structures.
    a. Study of complementary algorithms, which allows to solve a large variety of waveguides which may be made of any material and of almost any geometry.
    b. How to model propagation in 2D and 3D structures thanks to its propagation module FIMMPROP.
3. Harold: Advance Heterostructure model.
4. Optodesigner:
    a. Photonic chip and mask layout
    b. OptoDesigner advanced connectors and autorouting
    c. OptoDesigner simulation modules
    d. Photonic design verification

1.3 SKILLS AND METHODOLOGY

With these contents, the students have acquired a set of **competences**:

- Ability to project, calculate and design products, processes and facilities in photonics areas.
- Capacity for mathematical modeling, calculation and simulation in engineering companies, particularly in research, development and innovation tasks in areas related to photonics and associated multidisciplinary fields.
- Ability to apply acquired knowledge and to solve problems in new or unfamiliar environments within broader and multidiscipline contexts, being able to integrate knowledge.
- Ability to apply advanced knowledge of photonics, optoelectronics and high-frequency electronics.

The **methodology** applied was based in:

Lectures in the laptop: The professor introduces the main contents of each chapter to the students using laptop guided content provided by Photon Design and Optodesigner. These lectures did not cover all the contents of each subject. For that reason, the students had to review the supplementary notes provided in class and follow detailed instructions to perform different case studies parametrizing different variables in each exercise.

Laboratory: The lectures included some exercises in the lab involving different optical devices and optical communication systems.

Case studies: It consisted on activities that complement the master sessions and allow a better understanding of the theoretical concepts.

1.4 AGENDA

The agenda for SC4 can be found below. With this schedule the students fulfilled the five ECTS intended for this scientific course with an intensive training scheme. Finally, as a remark, not only the ESRs attended the courses. As they are part of the Doc_TIC program, two other PhD students also participated in the sessions scheduled.

Week 7	Mon jul 22	Tue jul 23	Wed jul 24	Thu jul 25	Fri jul 26	Sat jul 27	Sun jul 28
9:00							
10:00	SC4	SC4		BANK HOLIDAY	BANK HOLIDAY		
11:00			SC4				
12:00							
13:00							
14:00							
15:00							
16:00							
17:00							
18:00							
19:00							

Week 8	Mon jul 29	Tue jul 30	Wed jul 31	Thu ago 1	Fri ago 2	Sat ago 3	Sun ago 4
9:00							
10:00	SC4	SC4					
11:00							
12:00							
13:00							
14:00							
15:00							
16:00							
17:00							
18:00							
19:00							